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TITLE: IMAGE PICK-UP APPARATUS
AND IMAGE PICK-UP METHOD

Hon. Commissioner of Patents and Trademarks,
Washington, D.C. 20231

S I R:

CERTIFIED TRANSLATION

I, Masaaki Iwami of 3-22, Asagaya-minami 1-chome, Suginami-ku, Tokyo, Japan, am an experienced translator of the Japanese language into the English language and I hereby certify that the attached comprises an accurate translation into English of Japanese Patent Application No. 2000-112345 filed April 13, 2000.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

October 30, 2007
Date

Masaaki IWAMI

[Name of Document] Specification

[Title of the Invention] Imaging Device, Imaging Method, Program Recording Medium, and Data Recording Medium

[What is Claimed is]

[Claim 1]

An image pick-up control apparatus which controls exposure encountered when an image of an object is picked up, the apparatus comprising:

evaluating means for evaluating an electric signal outputted by photo-electric conversion means which receives light from the object for photo-electric conversion; and

setting means, on the basis of an evaluation result of the evaluating means, for setting exposure time of exposure control means with respect to a light receiving surface of the photo-electric conversion means in predetermined plane units each smaller than the light receiving surface, the exposure control means controlling exposure with respect to the light receiving surface.

[Claim 2]

The image pick-up control apparatus according to claim 1, wherein the exposure control means is one that can control exposure with respect to the light receiving surface in the predetermined plane units.

[Claim 3]

The image pick-up control apparatus according to claim 1, wherein the predetermined plane is a pixel.

[Claim 4]

The image pick-up control apparatus according to claim 3, wherein the evaluating means evaluates, for each pixel, a pixel value which is an electric signal for the pixel, and is outputted by the photo-electric conversion means.

[Claim 5]

The image pick-up control apparatus according to claim 3, further comprising storage means for storing a pixel value which is an electric signal for the pixel, and is outputted by the photo-electric conversion means.

[Claim 6]

The image pick-up control apparatus according to claim 5, wherein the storage means stores the pixel value together with exposure time for the pixel.

[Claim 7]

The image pick-up control apparatus according to claim 5, further comprising correcting means for correcting the pixel value on the basis of exposure time for the pixel.

[Clam 8]

The image pick-up control apparatus according to claim 1, further comprising the photo-electric conversion means and the exposure control means.

[Claim 9]

An image pick-up control method of controlling exposure encountered when an image of an object is picked up, the method comprising:

an evaluating step of evaluating an electric signal outputted by photo-electric conversion means which receives light from the object for photo-electric conversion; and

a setting step, on the basis of an evaluation result of the evaluating means, of setting exposure time of exposure control means with respect to a light receiving surface of photo-electric conversion means which receives the light, in predetermined plane units each smaller than the light receiving surface, the exposure control means controlling exposure with respect to the light receiving surface.

[Claim 10]

A program recording medium recorded with a program adapted to allow a computer to perform an image pick-up control process for controlling exposure encountered when an image of an object is picked up, the program

comprising:

an evaluating step of evaluating an electric signal outputted by photo-electric conversion means which receives light from the object for photo-electric conversion; and

a setting step, on the basis of an evaluation result of the evaluating means, of setting exposure time of exposure control means with respect to a light receiving surface of the photo-electric conversion means which receives the light, in predetermined plane units each smaller than the light receiving surface, the exposure control means controlling exposure with respect to the light receiving surface.

[Claim 11]

A data recording medium recorded with an image picked up by an image pick-up apparatus,

wherein exposure time encountered when the image is picked up by the image pick-up apparatus is recorded together with a pixel value constituting the image, in predetermined plane units each smaller than a frame of the image.

[Claim 12]

An image pick-up control apparatus which controls pick-up of an image of an object, the apparatus

comprising:

setting means for setting a plurality of exposure times of exposure control means with respect to a light receiving surface of photo-electric conversion means which receives light from the object for photo-electric conversion, the exposure control means controlling exposure with respect to the light receiving surface;

selector means for selecting one pixel value for a pixel of a respective position from a plurality of pixel values for pixels of respective positions constituting a plurality of images as electric signals outputted from the photo-electric conversion means with respect to the plurality of respective exposure times; and

constituting means for constituting an image of one frame on the basis of he pixel value selected by the selector means.

[Claim 13]

The image pick-up control apparatus according to claim 12, further comprising:

evaluating means for evaluating the plurality of pixel values for the pixels of respective positions constituting the plurality of images;

wherein the evaluating means selects a pixel value on the evaluation result of the evaluating means.

[Claim 14]

The image pick-up control apparatus according to claim 12, further comprising:

evaluating means for evaluating the plurality of pixel values for the pixels of respective positions constituting the plurality of images;

wherein the setting means sets the plurality of exposure times on the basis of the evaluation result of the evaluating means.

[Claim 15]

The image pick-up control apparatus according to claim 12, wherein the constituting means constitutes the image of one frame by allowing the storage means to store the pixel value.

[Claim 16]

The image pick-up apparatus according to claim 15, wherein the storage means stores the pixel value together with exposure time, of the plurality of exposure times, encountered when the image value is obtained.

[Claim 17]

The image pick-up control apparatus according to claim 12, further comprising correcting means for correcting the pixel value on the basis of the exposure time encountered when the pixel value is obtained.

[Claim 18]

The image pick-up control apparatus according to claim 12, further comprising the photo-electric conversion means and the exposure control means.

[Claim 19]

An image pick-up control method of controlling pick-up of an image of an object, the method comprising:

setting step of setting a plurality of exposure times of exposure control means with respect to a light receiving surface of photo-electric conversion means which receives light from the object for photo-electric conversion, the exposure control means controlling exposure with respect to the light receiving surface;

selecting step of selecting one pixel value for a pixel of a respective position from a plurality of pixel values for pixels of respective positions constituting a plurality of images as electric signals outputted from the photo-electric conversion means with respect to the plurality of respective exposure times; and

constituting step of constituting an image of one frame on the basis of the pixel value selected by the selector means.

[Claim 20]

A program recording medium recorded with a program

adapted to allow a computer to perform an image pick-up control process for controlling pick-up of an image of an object, the program comprising:

setting step of setting a plurality of exposure times of exposure control means with respect to a light receiving surface of photo-electric conversion means which receives light from the object for photo-electric conversion, the exposure control means controlling exposure with respect to the light receiving surface;

selecting step of selecting one pixel value for a pixel of a respective position from a plurality of pixel values for pixels of respective positions constituting a plurality of images as electric signals outputted from the photo-electric conversion means with respect to the plurality of respective exposure times; and

constituting step of constituting an image of one frame on the basis of the pixel value selected by the selector means.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Pertains]

This invention relates to an image pick-up apparatus, an image pick-up method, a program recording

medium, and a data structure, and more particularly to an image pick-up apparatus, an image pick-up method, a program recording medium, and a data structure adapted so as to have ability to obtain picture image of object of high contrast without losing its detail, e.g., in digital video camera, etc.

[0002]

[Prior Art]

For example, in digital video cameras, light from object is converged by lens onto the light receiving surface of photo-electric conversion device such as CCD (Charge Coupled Device), etc., at which photo-electric conversion is carried out so that picture image data which is electric signal is provided.

[0003]

In digital video cameras, light from lens is incident upon CCD through shutter which controls exposure. Accordingly, when shutter speed is low, i.e., exposure time is long, many electric charges are charged in CCD, resulting in the so-called over exposure. Further, picture image obtained at the time of over exposure results in the so-called white overexposure picture image. On the other hand, when exposure time is short, quantity of electric charges charged in CCD becomes lesser. As a

result, the so-called under exposure takes place, and picture image obtained results in black underexposure picture image.

[0004]

In order to prevent such white overexposure or black underexposure, it is necessary to set exposure time so that the area from the portion where picture image is the most bright up to the portion where it is the most dark has suitable brightness.

[0005]

[Problem to be Solved by the Invention]

Meanwhile, in conventional digital video cameras, photographing is carried out at the same exposure time with respect to the entirety of the light receiving surface of CCD.

[0006]

Accordingly, in the case where object of high contrast is photographed (imaged), the bright portion results in white overexposure portion, or the dark portion results in black underexposure portion, resulting in the problem that detail of object is lost in the picture image thus obtained.

[0007]

This invention has been made in view of such

circumstances and be able to pick-up image even object of high contrast without losing its detail.

[0008]

[Means for Solving the Problem]

A first image pick-up apparatus of the present invention is characterized by including: evaluating means for evaluating an electric signal outputted by photo-electric conversion means which receives light from the object for photo-electric conversion; and setting means, on the basis of an evaluation result of the evaluating means, for setting exposure time of exposure control means with respect to a light receiving surface of the photo-electric conversion means in predetermined plane units each smaller than the light receiving surface, the exposure control means controlling exposure with respect to the light receiving surface.

[0009]

In the first image pick-up control apparatus, the exposure control means is one that can control exposure with respect to the light receiving surface in the predetermined plane units.

[0010]

In the first image pick-up control apparatus, the predetermined plane is a pixel.

[0011]

In the first image pick-up control apparatus, the evaluating means evaluates, for each pixel, a pixel value which is an electric signal for the pixel, and is outputted by the photo-electric conversion means.

[0012]

The first image pick-up control apparatus can further include storage means for storing a pixel value which is an electric signal for the pixel, and is outputted by the photo-electric conversion means.

[0013]

In the first image pick-up control apparatus, the storage means stores the pixel value together with exposure time for the pixel.

[0014]

The first image pick-up control apparatus can further include correcting means for correcting the pixel value on the basis of exposure time for the pixel.

[0015]

The first image pick-up control apparatus can further include the photo-electric conversion means and the exposure control means.

[0016]

A first image pick-up control method of the present

invention is characterized by including: an evaluating step of evaluating an electric signal outputted by photo-electric conversion means which receives light from the object for photo-electric conversion; and a setting step, on the basis of an evaluation result of the evaluating means, of setting exposure time of exposure control means with respect to a light receiving surface of the photo-electric conversion means in predetermined plane units each smaller than the light receiving surface, the exposure control means controlling exposure with respect to the light receiving surface.

[0017]

A first program recording medium of the present invention is characterized by being recorded with a program including: an evaluating step of evaluating an electric signal outputted by photo-electric conversion means which receives light from the object for photo-electric conversion; and a setting step, on the basis of an evaluation result by the evaluating means, of setting exposure time of exposure control means with respect to a light receiving surface of the photo-electric conversion means in predetermined plane units each smaller than the light receiving surface, the exposure control means controlling exposure with respect to the light receiving

surface.

[0018]

A data recording medium of the present invention is characterized by being recorded with exposure time encountered when the image is picked up by the image pick-up apparatus together with a pixel value constituting the image, in predetermined plane units each smaller than a frame of the image.

[0019]

A second image pick-up control apparatus of the present invention is characterized by including: setting means for setting a plurality of exposure times of exposure control means with respect to a light receiving surface of photo-electric conversion means which receives light from the object for photo-electric conversion, the exposure control means controlling exposure with respect to the light receiving surface; selector means for selecting one pixel value for a pixel of a respective position from a plurality of pixel values for pixels of respective positions constituting a plurality of images as electric signals outputted from the photo-electric conversion means with respect to the plurality of respective exposure times; and constituting means for constituting an image of one frame on the basis of he

pixel value selected by the selector means.

[0020]

The second image pick-up control apparatus can further include evaluating means for evaluating the plurality of pixel values for the pixels of respective positions constituting the plurality of images. In this case, the evaluating means selects a pixel value on the basis of the evaluation result of the evaluating means.

[0021]

The second image pick-up control apparatus can further include: evaluating means for evaluating the plurality of pixel values for the pixels of respective positions constituting the plurality of images. In this case, the setting means sets the plurality of exposure times on the basis of the evaluation result of the evaluating means.

[0022]

In the second image pick-up control apparatus, the constituting means can constitute the image of one frame by allowing the storage means to store the pixel value.

[0023]

In the second image pick-up control apparatus, the storage means can store the pixel value together with exposure time, of the plurality of exposure times,

encountered when the image value is obtained.

[0024]

The second image pick-up control apparatus can further include correcting means for correcting the pixel value on the basis of the exposure time encountered when the pixel value is obtained.

[0025]

The second image pick-up control apparatus can further include the photo-electric conversion means and the exposure control means.

[0026]

A second image pick-up control method of the present invention is characterized by including: a setting step of setting a plurality of exposure times of exposure control means with respect to a light receiving surface of photo-electric conversion means which receives light from an object for photo-electric conversion, the exposure control means controlling exposure with respect to the light receiving surface; a selecting step of selecting one pixel value for a pixel of a respective position from a plurality of pixel values for pixels of respective positions constituting a plurality of images as electric signals outputted from the photo-electric conversion means with respect to the plurality of

respective exposure times; and a constituting step of constituting an image of one frame on the basis of the pixel value selected by the selector means.

[0027]

A second program recording medium is characterized by being recorded with a program including: a setting step of setting a plurality of exposure times of exposure control means with respect to a light receiving surface of photo-electric conversion means which receives light from the object for photo-electric conversion, the exposure control means controlling exposure with respect to the light receiving surface; a selecting step of selecting one pixel value for a pixel of a respective position from a plurality of pixel values for pixels of respective positions constituting a plurality of images as electric signals outputted from the photo-electric conversion means with respect to the plurality of respective exposure times; and a constituting step of constituting an image of one frame on the basis of the pixel value selected by the selector means.

[0028]

In the first image pick-up control apparatus, image pick-up control method and program recording medium of the present invention, an electric signal outputted by

the photo-electric means which receives light from an object for photo-electric conversion is evaluated, and on the basis of the evaluation result, the exposure time of the exposure control means with respect to the light receiving surface of the photo-electric conversion means which receives the light is set in predetermined plane units each smaller than the light receiving surface, the exposure control means controlling exposure with respect to the light receiving surface.

[0029]

The data recording medium of the present invention is recorded with exposure time encountered when an image is picked up by the image pick-up apparatus, in predetermined plane units each smaller than a frame of the image, along with a pixel value constituting the image.

[0030]

In the second image pick-up control apparatus, image pick-up control method and program recording medium of the present invention, a plurality of exposure times of the exposure control means with respect to a light receiving surface of the photo-electric conversion means are set, the exposure control means controlling exposure with respect to the light receiving surface of the photo-

electric conversion means which receives light from an object for photo-electric conversion, and one pixel value for a pixel of a respective position is selected from a plurality of pixel values for pixels of respective positions constituting a plurality of images as electric signals outputted from the photo-electric conversion means with respect to the plurality of respective exposure times. Then, the pixel value thus selected constitutes an image of one frame.

[0031]

[Mode for Carrying out the Invention]

FIG. 1 shows an example of the configuration of the first embodiment of the digital video camera according to the present invention.

[0032]

Light from object is incident upon a lens 1, and the lens 1 converges that light onto the light receiving surface of a CCD 3 through a shutter 2.

[0033]

The shutter 2 is controlled by a controller 5, and serves to reflect light from the lens 1, e.g., in pixel units constituting the light receiving surface of the CCD 3 to thereby control exposures with respect to respective pixels of the CCD 3.

[0034]

Namely, in FIG. 1, the shutter 2 is constituted with, e.g., DMD (Digital Micromirror Device) in which a large number of very small reflection mirrors are formed on semiconductor substrate, and respective mirrors are rotated in accordance with control from the controller 5 so that reflection direction of light incident thereupon can be changed in those mirror units.

[0035]

In this example, respective mirrors constituting DMD correspond to respective pixels constituting the CCD 3. Accordingly, by changing reflection direction of light of the respective mirrors, incidence of light upon corresponding pixels can be turned ON/OFF.

[0036]

It is to be noted that DMD is disclosed in, e.g., the Japanese Patent Application No. Hei 8-21977.

[0037]

The CCD 3 receives light from the shutter 2 in respective pixels constituting that light receiving surface to thereby charge electric charges corresponding to that light quantity. Further, the CCD 3 carries out the so-called bucket brigade of electric charges charged in respective pixels to output electric signal of

corresponding voltage level to an A/D (Analog/Digital) converter 4.

[0038]

The A/D converter 4 carries out sampling of electric signal from the CCD 3 at timing corresponding to pixels to quantize it to thereby deliver pixel values of respective pixels constituting digital picture image data to the controller 5.

[0039]

The controller 5 evaluates pixel values of respective pixels delivered through the A/D converter 4 from the CCD 3. Further, the controller 5 sets, in respective pixel units, exposure time by shutter 2 on the basis of the evaluation result to control the shutter 2.

[0040]

Further, the controller 5 corrects, as occasion demands, pixel values of respective pixels delivered through the A/D converter 4 from the CCD 3 on the basis of exposure time set when those pixel values are obtained to output, picture image data of, e.g., 1 frame (or 1 field) units consisting of corrected pixel values. The image data outputted by the controller 5 is recorded in a recording medium 7, such as, e.g., a semiconductor memory, a magneto-optical disc, a magnetic disc, a magnetic tape,

or a phase change disc, etc., or is caused to undergo transmission through a transmission medium 8, such as, e.g., a ground wave wireless circuit, a satellite circuit, a CATV (Cable Television) network, the Internet, a public circuit, or a bus, etc.

[0041]

A memory 6 temporarily stores data necessary for processing of the controller 5.

[0042]

FIG. 2 shows an example of configuration of a second embodiment of the digital video camera according to the present invention. It is to be noted that the same reference numerals are respectively attached to portions corresponding to the case in FIG. 1 in the figure and its explanation will be omitted as occasion demands.

[0043]

Namely, the digital video camera 101 of FIG. 2 is constituted essentially similarly to the digital video camera of FIG. 1. In FIG. 2, the shutter 2 is constituted with liquid crystal panel.

[0044]

The shutter 2 constituted with the liquid crystal panel is controlled by the controller 5 to allow light from the lens 1 to be transmitted in pixel units

constituting, e.g., light receiving surface of the CCD 3 to thereby control exposures with respect to respective pixels of the CCD 3.

[0045]

Namely, in FIG. 2, direction of liquid crystal molecules constituting liquid crystal panel as the shutter 2 is changed in units corresponding to pixel in accordance with control of the controller 5 so that transmission of light in that unit is limited. Thus, incidence of light upon corresponding pixel can be turned ON/OFF.

[0046]

FIG. 3 shows an example of the configuration of the controller 5 of FIGS. 1 and 2.

[0047]

The controller 5 is constituted with a picture evaluating section 11 and a shutter control section 12.

[0048]

Pixel value delivered from the CCD 3 to the controller 5 through the A/D converter 4 is received at the picture evaluating section 11. The picture evaluating section 11 implements necessary processing to pixel value delivered thereto to constitute picture image data of one frame to output such picture image data. Further, the

picture evaluating section 11 evaluates pixel value delivered thereto to set, in pixel units, exposure time by the shutter 2 on the basis of the evaluation result.

[0049]

The shutter control section 12 controls the shutter 2 in accordance with exposure time every pixel set at the picture evaluating section 11.

[0050]

FIG. 4 shows an example of the configuration of the picture evaluating section 11 of FIG. 3.

[0051]

Pixel value delivered from the CCD 3 to the controller 5 through the A/D converter 4 is received at a buffer 21, and the buffer 21 temporarily stores its pixel value.

[0052]

A pixel value correcting section 22 reads out pixel value stored in the buffer 21 and reads out, from a memory 25, exposure time with respect to pixel when corresponding pixel value is obtained to deliver them to the memory 6 in a manner such that they are caused to correspond to each other to allow the memory 6 to store them. Further, the pixel value correcting section 22 is operative so that when, e.g., set of pixel value and

exposure time corresponding to one frame is stored in the memory 6, it reads out the set of pixel value and exposure time to correct pixel value on the basis of exposure time to output picture image data of one frame constituted by the corrected pixel value.

[0053]

An evaluating section 23 evaluates pixel value stored in the buffer 21 to deliver its evaluation result to a shutter speed determining section 24. The shutter speed determining section 24 sets exposure time with respect to pixel of pixel value stored in the buffer 21 on the basis of evaluation result from the evaluating section 23.

[0054]

Namely, the evaluating section 23 evaluates pixel value stored in the buffer 21 to obtain evaluation result of whether pixel value is above upper limit or below lower limit, or movement quantity of object, etc. to deliver its evaluation result to the shutter speed determining section 24. The shutter speed determining section 24 is adapted so that when, e.g., pixel value is value above a predetermined value and there results white overexposure state, it sets exposure time with respect to corresponding pixel to shorter value. Moreover, the

picture evaluating section 11 is adapted so that when, e.g., pixel value is value below predetermined value and there results black underexposure state, it sets exposure time with respect to corresponding pixel to longer value. Further, the picture evaluating section 11 is adapted so that when, e.g., movement quantity of object is large and there results unintentional movement, it sets exposure time with respect to corresponding pixel to shorter value. In addition, the picture evaluating section 11 is adapted so that when, e.g., movement quantity of object is small (no movement quantity) and there results no unintentional movement, exposure time with respect to corresponding pixel is caused to remain at present value.

[0055]

Further, the shutter speed determining section 24 delivers exposure time set with respect to pixel to a memory 25.

[0056]

The memory 25 stores (overwrites) exposure time with respect to pixels from the shutter speed determining section 24 at address of corresponding position. Exposure time with respect to respective pixels stored in the memory 25 are delivered to a shutter control section 12, and the shutter control section 12 controls the shutter 2

in accordance with exposure time every respective pixels. Thus, incident time of light upon the CCD 3 through the shutter 2 is controlled every pixel.

[0057]

Here, the exposure time is the shutter speed, same as hereinafter. The fact that the exposure time is long corresponds to the fact that the shutter speed is slow and the fact that the exposure time is short corresponds to the fact that the shutter speed is fast.

[0058]

The operation of the digital video camera of FIG. 3 (FIGS. 1 and 2) will now be described with reference to the flowchart of FIG. 5.

[0059]

Initially, at step S1, the shutter speed determining section 24 of the controller 5 (FIG. 4) sets shutter speed of default with respect to respective pixels to transmit such shutter speed to the memory 25 to allow the memory 25 to store them at corresponding addresses.

[0060]

The shutter control section 12 controls the shutter 2 in accordance with shutter speed every pixels stored at the memory 25. Thus, while incident times of light upon

CCD 3 through the shutter 2 are controlled every pixel, electric charges are charged at respective pixels of the CCD 3.

[0061]

Further, when there results read-out start timing of pixel value constituting one frame, its read-out operation is started from the CCD 3 at step S2. Pixel value which has been read out from the CCD 3 is delivered to a buffer 21 of the controller 5 (FIG. 4) through the A/D converter 4, and is stored thereat.

[0062]

Pixel value stored in the buffer 21 is read out by pixel value collecting section 22 at step S3. Further, at the step S3, the pixel value collecting section 22 reads out shutter speed stored at address of the memory 25 corresponding to pixels (hereinafter referred to as remarked pixel) of pixel values which have been read out from the buffer 21, i.e., caused to correspond to pixel value of remarked pixel to allow the memory 6 to store.

[0063]

Further, processing proceeds to step S4. The evaluating section 23 evaluates pixel value of remarked pixel stored at the buffer 21 to deliver its evaluation result to the shutter speed determining section 24. The

shutter speed determining section 24 sets, for a second time, shutter speed of remarked pixel to reasonable value as described above on the basis of evaluation result from the evaluating section 23 at step S5. Further, the shutter speed determining section 24 delivers the shutter speed which has been set for a second time to the memory 25 to allow the shutter speed to be stored (overwritten) in address corresponding to remarked pixel.

[0064]

Thereafter, processing proceeds to step S6. Whether or not read-out operation of all pixel values Constituting one frame from the CCD 3 is completed is judged. In the case where it is judged that read-out operation is not yet completed, processing proceeds to step S7, at which pixel value of the next pixel is acquired from the CCD 3. Thus, processing returns to the step S3. Further, processing at step S3 and at steps subsequent thereto will be repeated with pixel of that pixel value being newly as remarked pixel.

[0065]

On the other hand, in the case where it is judged at the step S6 that read-out operation of all pixel values constituting one frame is completed, i.e., in the case where pixel values of all pixels constituting one

frame and shutter speed caused to correspond thereto are stored, processing proceeds to step S8. Thus, the pixel value correcting section 22 (FIG. 4) reads out respective pixel values from the memory 6 to correct respective pixel values on the basis of shutter speed to correspond to those pixel values to output picture image data of one frame constituted with corrected pixel value.

[0066]

Namely, since respective pixel values constituting one frame are not pixel values obtained by the same shutter speed, when such pixel values are used as they are to constitute picture of one frame, there results a picture image in which brightness is sparse or thin. In view of this, the pixel value correcting section 22 corrects respective pixel values on the basis of shutter speed to thereby constitute a picture image such that there is feeling of unity in brightness and all pixels are photographed by the same shutter speed.

[0067]

In more practical sense, for the purpose of simplifying explanation, e.g., right now, inverse of shutter speed (corresponds to exposure time) and pixel value are assumed to be proportional relationship. In the pixel value correcting section 22, when, e.g., the

fastest shutter speed (hereinafter referred to as fastest shutter speed) $1/S_{BASE}$ [sec.] of shutter speed stored in the memory 6 is assumed as reference, pixel values to which shutter speed other than fastest shutter speed 1/S [sec.] are caused to correspond are changed to multiple of S/S_{BASE}.

[0068]

Therefore, when pixel value that the A/D converter 4 outputs is assumed to be M bits, there are the cases where pixel value constituting corrected picture that the pixel value correcting section 22 outputs may be the number of bits above M bits.

[0069]

As a result, from the pixel value correcting section 22, even if object has high contrast, picture image in which its contrast is sufficiently represented is outputted.

[0070]

While the fastest shutter speed is caused to be reference in this example, shutter speed serving as reference may be arbitrary value. Namely, shutter speed serving as reference may be shutter speed except for the fastest shutter speed stored in the memory 6, or may be shutter speed which is not stored in the memory 6.

[0071]

When picture image data consisting of corrected pixel value as stated above is outputted at step S8, processing proceeds to step S9. As the result of the fact that processing of steps S4 to S7 are repeated, shutter speed every respective pixels stored in the memory 25 are transmitted to shutter control section 12. Thus, processing returns to the step S2. At times subsequent thereto, with respect to the next frame, similar processing is repeated. Accordingly, with respect to the next frame, imaging of picture is carried out by shutter speed every respective pixels stored in the memory 25.

[0072]

As described above, such an approach is employed to evaluate pixel value that the CCD 3 outputs to set, in pixel units, shutter speed with respect to the light receiving surface of the CCD 3 by the shutter 2 on the basis of its evaluation result to carry out image pick-up operation of object. Accordingly, even if there is employed object of high contrast, it is possible to obtain picture of which detail is not injured.

[0073]

Moreover, in general, the dynamic range of CCD is not so broad, but shutter speed are controlled every

pixels as described above, thereby making it possible to provide the effect similar to the case where the dynamic range of the CCD 3 is broadened.

[0074]

While, in the above-described case, such an approach is employed to collect respective pixel values stored in the memory 6 on the basis of shutter speed caused to correspond to those pixel values and to output them, respective pixel values stored in the memory 6 may be outputted along with shutter speed caused to correspond to those pixel values as they are to record such pixel values onto recording medium 7 or to carry out transmission thereof through transmission medium 8.

[0075]

FIG. 6 shows an example of the configuration of a third embodiment of digital video camera according to the present invention. It is to be noted that the same reference numerals are respectively attached to portions corresponding to the case in FIG. 1 or FIG. 2 in the figure, and their explanation will be omitted as occasion demands. Namely, the digital video camera of FIG. 6 is constituted essentially similarly to the case in FIG. 1 or FIG. 2 except that a memory controller 31 and memories 32_1, 32_2, $\cdots$, 32_N are newly provided and a controller 33 is

provided in place of the controller 5.

[0076]

However, shutter 2 is constituted with DMD similarly to the case in FIG. 1 in the embodiment of FIG. 6, in FIG. 6, the shutter 2 is only required to have ability to equally turn ON/OFF incidence of light upon the CCD 3 with respect to all pixels constituting the CCD 3. Accordingly, there is no necessity to constitute DMD.

[0077]

The memory controller 31 delivers pixel value delivered through the A/D converter 4 from the CCD 3 to any one of frame memories 32_1 to 32_N in accordance with control from the controller 33 to allow it to store the pixel value.

[0078]

The memories 32_1 to 32_N are adapted to store pixel value delivered from the memory controller 31.

[0079]

The controller 33 sets plural shutter speed in the shutter 2 to control the shutter 2 by respective plural shutter speed so that light from object is incident upon the CCD 3. Accordingly, in this case, in the CCD 3, pixel values constituting one frame are outputted with respect to respective plural shutter speed set at the controller

33. Namely, rays of light by respective plural shutter speed that the controller 33 has set are incident, within period, upon the CCD 3. Thus, at the CCD 3, with respect to respective frames, pixel values of plural pictures corresponding to respective plural shutter speed are outputted.

[0080]

Further, the controller 33 controls the memory controller 31 in a manner as described above so that pixels constituting plural pictures corresponding to respective plural shutter speed are stored into the same memory 32_n (n = 1, 2, ···, N) each shutter speed. For example, in the controller 33, when N shutter speed are assumed to be set and shutter speed fast at the n-th order is assumed to be the n-th shutter speed, the controller 33 controls the memory controller 31 so that pixel value of picture corresponding to the n-th shutter speed outputted through the A/D converter 4 from the CCD 3 is stored into the memory 32_n.

[0081]

Moreover, the controller 33 selects one pixel value with respect to pixel of that position from plural pixel values of pixels of the same position constituting pictures corresponding to plural shutter speed stored in

respective memories 32_1 to 32_N to constitute picture of one frame by the selected pixel value.

[0082]

Further, similarly to the controller 5, the controller 33 corrects, as occasion demands, pixel values constituting picture of one frame constituted in a manner as described above on the basis of shutter speed when those pixel values are obtained to output, in units of one frame, for example, picture image data consisting of the corrected pixel value.

[0083]

In the following description, at the controller 33, N(N is integer equal to 2 or more) shutter speed as plural shutter speed are assumed to be set.

[0084]

FIG. 7 shows an example of the configuration of the controller 33 of FIG. 6. It is to be noted that the same reference numerals are respectively attached to portions constituted similarly to the controller 5 of FIG. 4 in the figure and their explanation will be omitted as occasion demands.

[0085]

A read-out section 41 reads out pixel value of remarked pixel from any one of memories 32_1 to 32_N in

accordance with control of a control section 42 to deliver it to the buffer 21.

[0086]

The control section 42 controls the pixel value correcting section 22, the read-out section 41 and a reference parameter determining section 43 while making reference to evaluation result of pixel value stored in the buffer 21 by the evaluating section 23 and N shutter speed stored in the memory 44 as occasion demands.

[0087]

The reference parameter determining section 43 determines reference parameter serving as reference in determining N shutter speed on the basis of control from the control section 42.

[0088]

Namely, the reference parameter determining section 43 determines, as reference parameter, e.g., parameter for determining one shutter speed serving as reference and the remaining N-1 shutter speed with that shutter speed being as reference.

[0089]

In this case, as parameter for determining other (N-1) shutter speed of the shutter speed serving as reference, there are, e.g., parameters as described below.

Namely, in digital video cameras, in general, plural shutter speed which can be used are set in advance. Accordingly, in the case where a certain shutter speed is caused to be reference, shutter speed fast by one step (stage) with respect thereto or shutter speed slow by one step (stage) with respect thereto is univocally determined. Accordingly, such number of steps (stages) may be used as reference parameter.

[0090]

When the reference parameter determining section 43 determines reference parameter, it sets N shutter speed on the basis of the reference parameter. Namely, the reference parameter determining section 43 allows, e.g., shutter speed determined as reference parameter to be the first shutter speed which is the fastest value of N shutter speed, and allows shutter speed slower every number of stages determined as reference parameter to be set to the second shutter speed, the third shutter speed, ···, the N-th shutter speed in order.

[0091]

Accordingly, when, e.g., plural shutter speed set in advance in digital video camera are expressed as S_1, S_2, ···, S_N (M is integer value larger than N) in order of faster shutter speed, N shutter speed of S_k, S_{k-1}, ···, S_{k-N+1}

are set with respect to the reference parameter where shutter speed of reference is S_k (k is integer greater than 1 and smaller than M) and the number of stages is 1. Moreover, with respect to reference parameter where, e.g., shutter speed of reference is S_k and the number of stages is 2, N shutter speed of S_k, S_{k-2}, S_{k-4}, $\cdots$, $S_{k-2(N-1)}$ are set.

[0092]

It is to be noted that, at the reference parameter determining section 43, at the time of setting N shutter speed on the basis of reference parameter, such an approach may be also employed to linearly or non-linearly change the number of stages of those N shutter speed adjacent to each other. Namely, at the reference parameter determining section 43, N shutter speed, e.g., S_k, S_{k-1}, S_{k-3}, S_{k-6}, S_{k-10}, $\cdots$, can be set.

[0093]

The memory 44 stores (overwrites) N shutter speed set at the reference parameter determining section 43.

[0094]

N shutter speed stored in the memory 44 are adapted so that they are delivered to shutter control section 12, memory controller 31 (FIG. 6) and control section 42. Thus, the shutter control section 12 controls the shutter 2 so that light from object is incident upon the CCD 3 at

respective N shutter speed, and the memory controller 31 allows any one of memories 32_1 to 32_N to store, every shutter speed, pixel values from A/D converter 4 which are obtained with respect to N shutter speed.

[0095]

The operation of the digital video camera of FIG. 6 will be described with reference to the flowchart of FIG. 8.

[0096]

First of all, at step S21, the reference parameter determining section 43 of the controller 33 (FIG. 7) sets N shutter speed on the basis of reference parameter of default to transmit such shutter speed to the memory 44 to allow the memory 44 to store them.

[0097]

The shutter control section 12 controls the shutter 2 in accordance with respective N shutter speed stored in the memory 44, i.e., controls the shutter 2 in accordance with respective N shutter speed in tine divisional manner within frame period. Thus, pixel values constituting pictures corresponding to respective N shutter speed are outputted in time divisional manner from the CCD 3.

[0098]

Pixel values constituting pictures corresponding to

respective N shutter speed that the CCD 3 outputs in time divisional manner are delivered to the memory controller 31.

[0099]

The memory controller 31 makes reference to the memory 44 to thereby recognize respective N shutter speed to deliver pixel value constituting picture image corresponding to the first shutter speed) (the fastest shutter speed of the N shutter speed) to memory 32_1 to store it at address corresponding to pixel of that pixel value. Similarly, the memory controller 32 respectively also delivers pixel values constituting pictures corresponding to the second shutter speed to the N-th shutter speed to memories 32_2 to 32_N to allow those memories to store such pixel values.

[0100]

Thus, pixel values obtained at different shutter speed with respect to pixels constituting picture of the same content are stored in the memories 32_1 to 32_N.

[0101]

Thereafter, processing proceeds to step S22. The control section 42 allows pixels constituting picture to be remarked pixel by, e.g., raster scan order to control the read-out section 41 to thereby allow memories set at

default (default memories) of memories 32_1 to 32_N to read out pixel value of remarked pixel stored thereat.

[0102]

It is to be noted that memory caused to serve as default memory is not particularly limited, but arbitrary memory, e.g., memory $32_{n/2}$ or $32_{(N-1)/2}$, etc. of memories 32_1 to 32_N may be default memory.

[0103]

In this example, memories that the read-out section 41 reads out pixel value of memories 32_1 to 32_N will be referred to as remarked memory as occasion demands.

[0104]

When the read-out section 41 reads out pixel value of remarked pixel from the remarked memory in accordance with control of the control section 42, it delivers its pixel value to the buffer 21 to allow the buffer 21 to store the pixel value. Thus, processing proceeds to step S23.

[0105]

At step S23, the evaluating section 23 evaluates pixel value of remarked pixel stored in the buffer 21 to output its evaluation result to the control section 42. Thus, processing proceeds to step S24

[0106]

At the step S24, the control section 42 judges on the basis of evaluation result from the evaluating section 23 whether or not pixel value of remarked pixel is in white overexposure state. In the state where it is judged at the step S24 that pixel value of the remarked pixel is in white overexposure state, i.e., in the case where shutter speed used when pixel value which has been read out from the remarked memory is too slow (in the case where exposure time is too long) processing proceeds to step S25. The control section 42 judges whether or not the remarked memory is memory in which pixel value of picture corresponding to the fastest shutter speed (the first shutter speed) (hereinafter referred to as fastest memory as occasion demands) (memory 32_1 in this embodiment).

[0107]

In the case where it is judged at the step S25 that the remarked memory is not the fastest memory, processing proceeds to step S26. The control section 42 controls the read-out section 41 to thereby change the remarked memory to memory in which pixel value of picture corresponding to next faster shutter speed is stored. Namely, in this embodiment, when the remarked memory is assumed to be memory 32_n, the control section 42 changes the remarked

memory from memory 32_n to memory 32_{n-1}. Further, the control section 42 controls the read-out section 41 in a manner to read out pixel value of the remarked pixel from the changed remarked memory. Thus, processing returns to the step S23 and similar processing will be repeated at times subsequent thereto.

[0108]

Moreover, it is judged at the step S25 that the remarked memory is the fastest memory, i.e., in the case where even when there is employed pixel value obtained by using the fastest shutter speed of N shutter speed set now, there is in white overexposure state, and there is thus necessity to shorten shutter speed in order to avoid while overflow state, processing proceeds to step S27. The control section 42 delivers request for allowing the entirety of N shutter speed or a portion thereof (e.g., several faster shutter speed of N shutter speed) to the reference parameter determining section 43. Thus, processing proceeds to step S28.

[0109]

On the other hand, in the case where it is judged at the step S24 that pixel value of remarked pixel is not in the white overexposure state, processing proceeds to step S29. The control section 42 judges on the basis of

evaluation result from the evaluating section unit 23 whether or not pixel value of remarked pixel is in the state of black underexposure. In the case where it is judged at the step 29 that pixel value of the remarked pixel is in the state of black underexposure, i.e., in the case where shutter speed used when pixel value which has been read out from the remarked memory is obtained is too fast (in the case when exposure time is too short), processing proceeds to step S30. The control section 42 judges whether or not the remarked memory is memory in which pixel value of picture corresponding to the slowest shutter speed (the N-th shutter speed in this embodiment) (hereinafter referred to as slowest memory) (memory 32_n in this embodiment).

[0110]

In the case where it is judged at the step S30 that the remarked memory is not the slowest memory, processing proceeds to step S31. The control section 42 controls the read-out section 41 to thereby change the remarked memory to memory in which pixel value of picture corresponding to shutter speed slower next is stored. Namely, in this embodiment, when the remarked memory is memory 32_n, the control section 42 changes the remarked memory from memory 32_n to memory 32_n+1. Further, the control section

42 controls the read-out section 41 so as to read out pixel value of remarked pixel from the changed remarked memory. Thus, processing returns to the step S23, and similar processing will be repeated at times subsequent thereto.

[0111]

Moreover, in the case where it is judged at the step S30 that the remarked memory is the slowest memory, i.e., in the case where even when there is employed pixel value obtained by using the slowest shutter speed of N shutter speed set now, there is in the state of black underexposure, and there is thus necessity to allow the shutter speed to be slower in order to avoid the state of black underexposure, processing proceeds to step S32. The control section 42 delivers a request for allowing the entirety of N shutter speed or a portion thereof (e.g., several slower shutter speed of N shutter speed) to be slower to the reference parameter determining section 43. Thus, processing proceeds to step S28.

[0112]

On the other hand, in the case where it is judged at the step S29 that pixel value of remarked pixel is not in the state of black underexposure, i.e., in the case where pixel value of the remarked pixel is not in either

state of white overexposure and black underexposure, processing proceeds to the step S28. Thus, pixel value of remarked pixel stored in the buffer 21 is delivered to the pixel value correcting section 22. Moreover, at the step S28, the control section 42 recognizes shutter speed when pixel value stored in the buffer 21 is obtained by making reference to memory 44 to deliver its shutter speed to the pixel value correcting section 22. Further, at the step S28, the pixel value correcting section 22 allows pixel value of the remarked pixel from the buffer 21 and shutter speed used for obtaining that pixel value from the control section 42 to correspond to each other to deliver the pixel value and the shutter speed to the memory 6 to allow the memory 6 to store them.

[0113]

Accordingly, at the step S28, in principle, pixel values which are not in either state of white overexposure and black underexposure of plural pixel values stored in memories 32_1 to 32_N with respect to remarked pixel are selected and are stored into the memory 6.

[0114]

It is to be noted that in the case where there does not exist pixel value placed in the state of white

overexposure or black underexposure of plural pixel values stored in memories 32_1 to 32_N with respect to the remarked pixel, pixel value in which the degree of the state of white overexposure or black underexposure is the lowest is selected and is stored into the memory 6, and a request for change of shutter speed is made from the control section 42 to the reference parameter determining section 43 in order to cancel the state of that white overexposure or black underexposure.

[0115]

After pixel value and shutter speed of remarked pixel is caused to be stored into the memory 6, processing proceeds to step S33, at which whether or not all of pixel values constituting picture of one frame are written into the memory 6 is judged. In the case where it is judged at the step S33 that all of pixel values constituting picture of one frame are not yet written into the memory 6, processing proceeds to step S34. Pixel next to remarked pixel now in order of raster scan is caused to be newly remarked pixel. At the read-out section 41, pixel value of that remarked pixel is read out from the remarked memory. Further, processing returns to the step S23, and similar operation will be repeated at times subsequent thereto.

[0116]

Moreover, in the case where it is judged at the step S33 that all of pixels constituting one frame are written into the memory 6, i.e., in the case where pixel values of all pixels constituting one frame and shutter speed caused to correspond thereto are stored, processing proceeds to step S35. Thus, the pixel value collecting section 22 reads out respective pixel values from the memory 6 similarly to the case at the step S8 of FIG. 5 to correct respective pixel values on the basis of shutter speed caused to correspond to those pixel values to output picture image data of one frame constituted with the corrected pixel value.

[0117]

Further, processing proceeds to step S36. The reference parameter determining section 43 is operative so that in the case where there is request for allowing shutter speed to be faster or slower of shutter speed at step S27 or S32, it determines reference parameter for a second time so that shutter speed in accordance with that request is set. Further, the reference parameter determining section 43 sets N shutter speed for a second time on the basis of the reference parameter which has been determined for a second time. Thus, processing

proceeds to step S37.

[0118]

It is to be noted that in the case where there is no request for allowing shutter speed to be faster or slower, the reference parameter determining section 43 sets the same N shutter speed as those at previous time by using the reference parameter determined last as it is.

[0119]

At the step S37, the reference parameter determining section 43 delivers N shutter speed set at the step S36 to memory 44 to allow the memory to store them. Thus, processing returns to the step S22, and similar processing will be repeated with respect to the next frame at times subsequent thereto.

[0120]

As stated above, such an approach is employed to set plural shutter speed to obtain picture images corresponding to respective plural shutter speed to select pixel values which are not placed in the state of white overexposure and black underexposure to thereby constitute picture images of respective frames. Accordingly, even when there is employed object of high contrast, it is possible to obtain picture of which detail is not injured. Further, also in this case,

similarly to the case in FIG. 1 and FIG. 2, it is possible to provide the same effect as in the case where dynamic range of CCD is broadened.

[0121]

It is to be noted that, also in the embodiment of FIG. 6, respective pixel values stored in the memory 6 may be outputted along with shutter speed caused to correspond to those pixel values as they are and may be recorded onto recording medium 7 or may be caused to undergo transmission through the transmission medium 8.

[0122]

The above-described series of processing may be carried out by handware, or may be carried out by software. In the case where a series of processing are carried out by software, program constituting that software is installed into widely used computer, etc.

[0123]

FIG. 9 shows an example of the configuration of an embodiment of computer into which program which executes the above-described series of processing is installed.

[0124]

Program can be recorded in advance with respect to a hard disc 105 or a ROM 103 as recording medium included within the computer.

[0125]

Alternatively, program may be temporarily or permernently stored (recorded) on a removable recording medium 111 such as floppy disc, CD-ROM (Compact Disc Read Only Memory), MO (Magneto optical) disc, DVD (Digital Versatile Disc), magnetic disc, or semiconductor memory, etc. Such removable recording medium 111 can be provided as the so-called package software.

[0126]

In this case, program is installed from the removable recording medium 111 as described above into the computer. In addition, program may be transferred by wireless to the computer through artificial satellite for digital satellite broadcast from down load site, or may be transferred to the computer by wire through network such as LAN (Local Area Network) or internet. In the computer, program transferred in such a way may be received at a communication section 108 and installed into hard disc 105 included.

[0127]

The computer includes a CPU (Central Processing Unit) 102. An input/output interface 110 is connected to the CPU 102 through a bus 101. When command is inputted as the result of the fact that an input section 107

included of keyboard, mouse or microphone, etc. is operated or is caused to undergo similar operation by user through an input/output interface 110, the CPU 102 executes program stored in a ROM (Read Only Memory) 103 in accordance with the command. Alternatively, the CPU 102 loads, into a RAM (Random Access Memory) 104, program stored on the hard disc 105, program transferred from the satellite or the network, received at the communication section 108 and installed on the hard disc 105, or program read out from the removable recording medium 111 fitted at a drive 109 and installed on the hard disc 105, and executes such program. Thus, the CPU 102 carries out processing in accordance with the above-described flowchart, or processing carried out by the configuration of the above-described block diagrams. In addition, the CPU 102 outputs, e.g., as occasion demands its processing result from an output section constituted with LCD (Liquid Crystal Display) or speaker, etc. through the input/output interface 110, transmits it from the communication section 108 and records it onto the hard disc 105, etc.

[0128]

It is to be noted that, in this specification, it is not necessarily required to process processing steps

which describe program for allowing the computer to carry out various processing in a time divisional manner along the order described as the flowchart, and such processing steps include processing executed in parallel or individually (e.g., parallel processing or processing by object).

[0129]

Moreover, program may be processed by single computer, or may be caused to undergo distribution processing by plural computers. Further, program may be transferred to remote computer, at which it is executed.

[0130]

It is to be noted that while shutter capable of controlling exposure every respective pixels of CCD 3 is used as shutter 2 in the embodiments of FIGS. 1 to 3, there may be used, e.g., shutter capable of controlling exposure every plural pixels such as two pixels of CCD 3 in addition to the above as shutter 2.

[0131]

Further, this invention can be applied to both moving picture and still picture.

[0132]

[Effect of the Invention]

According to the first image pick-up control

apparatus, image pick-up control method and program recording medium of the present invention, an electric signal outputted by photo-electric conversion means which receives light from an object for photo-electric conversion is evaluated, and on the basis of the evaluation result, the exposure time of exposure control means with respect to the light receiving surface of the photo-electric conversion means which receives the light is set in predetermined plane units each smaller than the light receiving surface, the exposure control means controlling exposure with respect to the light receiving surface. Thus, an image of even an object with high contrast can be obtained without losing its details.

[0133]

According to the data recording medium of the present invention, exposure time encountered when an image is picked up by the image pick-up apparatus is recorded in predetermined plane units each smaller than a frame of the image, along with a pixel value constituting the image. Thus, an image entirely using uniform exposure can be obtained by correcting the pixel value on the basis of the exposure time.

[0134]

According to the second image pick-up control

apparatus, image pick-up control method and program recording medium of the present invention, a plurality of exposure times of the exposure control means with respect to a light receiving surface of the photo-electric conversion means are set, the exposure control means controlling exposure with respect to the light receiving surface of the photo-electric conversion means which receives light from an object for photo-electric conversion, and one pixel value for a pixel of respective position is selected from a plurality of pixel values for pixels of respective positions constituting a plurality of images as electric signals outputted from the photo-electric conversion means with respect to the plurality of respective exposure times. Then, the pixel value thus selected constitutes an image of one frame. Thus, an image of even an object with high contrast can be obtained without losing its details.

[Brief Description of the Drawings]

[FIG. 1]

FIG. 1 illustrates a digital video camera according to a first embodiment of the present invention by way of configurational example.

[FIG. 2]

FIG. 9 is a block diagram of a computer according to an embodiment of the present invention by way of configurational example.

[Description of Reference Symbols]

1 lens, 2 shutter, 3 CCD, 4 A/D converter, 5 controller, 6 memory, 7 recording medium, 8 transmission medium, 11 picture evaluating section, 12 shutter control section, 21 buffer, 22 pixel value correcting section, 23 evaluating section, 24 shutter-speed determining section, 25 memory, 31 memory controller, 32_1 through 32_N memory, 33 controller, 41 read-out section, 42 control section, 43 reference parameter determining section, 44 memory, 101 bus, 102 CPU, 103 ROM, 104 RAM, 105 hard disk, 106 output section, 107 input section, 108 communication section, 109 drive, 110 input/output interface, 111 removable recording medium

[Name of Document] Abstract of the Disclosure

[Abstract]

[Object] To obtain picture image of which detail is not injured, even in the case of object of high contrast.

[Solving Means] At a controller 5, pixel values that a CCD 3 outputs are evaluated. On the basis of the evaluation result, shutter speed with respect to a light receiving surface of the CCD 3 in a shutter 2 constituted with, e.g., DMD (Digital Micromirror Device), etc. are set in pixel units. Further, image pick-up of object is carried out by exposure time set in pixel units in that way. As a result, even in the case of object of high contrast, picture image of which detail is not injured can be obtained.

[Selected Drawing] FIG. 1

In the drawings:

[FIG. 1]

1-a: Incident light

1-b: Picture image data

1: Lens

2: Shutter (DMD)

4: A/D converter

5: Controller

6: Memory

[FIG. 2]

2-a: Incident light

2-b: Picture image data

1: Lens

2: Shutter (liquid crystal panel)

4: A/D converter

5: Controller

6: Memory

[FIG. 3]

3-a: Object

3-b: Output picture image

1: Lens

2: Shutter

4: A/D converter

5: Controller

6: Memory

11: Picture evaluating section

12: Shutter control section

[FIG. 4]

4-a: Pixel value

4-b: Pixel value and shutter speed (to memory 6)

4-c: Picture image data

4-d: To shutter 2

5: Controller

11: Picture evaluating section

12: Shutter control section

21: Buffer

22: Pixel value correcting section

23: Evaluating section

24: Shutter-speed determining section

25: Memory

[FIG. 5]

S1: Setting and transmitting of shutter speed

S2: Start of frame read-out

S3: Storage of pixel value and shutter speed

S4: Evaluation of pixel value

S5: Determination of shutter speed

S6: Frame read-out completed?

S7: Acquisition of next pixel

S8: Correction and output of pixel value

S9: Transmitting of shutter speed

[FIG. 6]

6-a: Incident light

6-b: Picture image data

2: Sutter

4: A/D converter

6: Memory

31: Memory controller

32_1 through 32_N: Memory

33: Controller

[FIG. 7]

7-a: Pixel value (from memories 32_1 through 32_N)

7-b: To shutter 2

7-c: To memory controller 31

7-d: Pixel value and shutter speed (to memory 6)

7-e: Picture image data

12: shutter control section

21: Buffer

22: Pixel value correcting section

23: Evaluating section

33: controller

41: Read-out section

42: Control section

43: Reference parameter determining section

44: Memory

[FIG. 8]

S21: Setting and transmitting of shutter speed

S22: Start of frame read-out from default memory

S23: Evaluation of pixel value

S24: White overexposure

S25: Remarked memory fastest memory?

S26: Changing of remarked memory

S27: Request for fastest shutter speed

S28: Storage of pixel value and shutter speed

S29: Black underexposure?

S30: Remarked memory slowest memory?

S31: Change of remarked memory

S33: request for slowing down shutter speed

S33: Frame write completed?

S34: Acquisition of next pixel

S35: Correction and output of pixel value

S36: Setting of reference parameter

S37: Transmitting of shutter speed

[FIG. 9]

9-a: Computer

101: Bus

105: Hard disk

106: Output section

107: Input section

108: Communication section

109: Drive

110: Input/output interface

111: Removable recording medium